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Building digital competencies to benefit from existing and emerging technologies, with a special focus on gender and youth dimensions

Report of the Secretary General

Executive summary

This report identifies the digital skills and competencies needed to exploit the development potential of existing and emerging digital technologies. It also considers how technological advances in information and communications technologies (ICTs) can help build digital skills. The report discusses the conditions and policies needed in countries, particularly in developing countries, to build digital competencies and prepare them for the current wave of technological changes. The report concludes by putting forward for consideration of Member States and the international community a set of recommendations on how to enhance digital competencies and skills.

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Introduction

1. At its twentieth session, held in Geneva, Switzerland in May 2017, the Commission on Science and Technology for Development selected as one of its two priority themes for the 2017–2018 intersessional period, "Building digital competencies to benefit from existing and emerging technologies, with a special focus on gender and youth dimensions".

2. To contribute to a better understanding of this priority theme and to assist the Commission in its deliberations at its twenty-first session, the secretariat of the Commission convened a panel meeting in Geneva from 6 to 8 November 2017. This report is based on the issues paper prepared by the Commission secretariat,[1] the findings of the panel, country case studies contributed by Commission members, relevant literature and other sources.

I. Technological change and its impact

3. Technological changes observed in recent years, particularly driven by the rapid development of ICTs, offers the potential to transform economies and improve the living standards of many people. Furthermore, it has a strong potential to disrupt productive sectors and markets, including through technological convergence and recombination.

4. Recent advances in ICTs, characterized by a reliance on digital data storage and analytics, fast-growing capabilities at a declining cost and increasing ease of use, have led to an increasing democratization of technologies. Examples of these technologies include the Internet of Things, big data, artificial intelligence, robotics, automation, three-dimensional printing, biotechnology, nano- and microsatellites, neurotechnology, synthetic biology, nanomaterials, advance energy storage technologies and blockchain.[2] The applications of these technologies offer new opportunities for economic prosperity, social inclusion, and environmental sustainability, including through technological convergence and recombination. Furthermore, the cross-cutting application of many emerging technologies, especially those digitally enabled, can also contribute to sustainable development.[3] Examples of these applications include sensor devices for improving agricultural productivity, microinsurance for farmers distributed through mobile devices, mapping data for the control of epidemic outbreaks and smart water-management systems.[4]

5. The implications of current technological advances for labour markets and jobs have been the subject of much debate, which has largely focused on the impact of digital platforms and automation. It has been observed that while digital platforms are creating new types of occupations and generating entrepreneurial opportunities – especially for women – they can also create greater pressure on pay and working conditions, owing to work fragmentation and the provision of remote services.[5] As regards automation, the increased automation of tasks can release workers from dangerous, predictable and routine tasks so they can pursue safer, more creative and interesting work tasks, as well as leisure activities. However, it can also reduce the need for workers and potentially even whole industries, since it raises productivity and can increase the scale of operations at marginal cost.[6] The net impact of new technologies and their consequences on labour

[1] The issues paper, presentations and contributions to the intersessional panel cited in this report are available at http://unctad.org/en/pages/MeetingDetails.aspx?meetingid=1562 (accessed 27 February 2018).

[2] Organization for Economic Cooperation and Development (OECD), 2016, *OECD Science, Technology and Innovation Outlook 2016* (OECD Publishing, Paris); E/CN.16/2016/3.

[3] A/72/257.

[4] E/CN.16/2016/3.

[5] J Drahokoupil and B Fabo, 2016, The platform economy and the disruption of the employment relationship, European Trade Union Institute Policy Brief No. 5.

[6] E/CN.16/2016/3.

markets and jobs remains uncertain, including on the type of jobs and sectors that will remain or will be created.

6. Technological change can affect women and men differently.[7] ICT services provide relatively well-remunerated employment for women, but the share of women in ICT specialist occupations remains very low, especially in developing countries.[8] A recent survey among 13 major developed and emerging economies revealed that female employment is concentrated in low-growth or declining occupations, such as sales, business and clerical work. Women are also less represented in sectors in which automation is expected to displace jobs such as manufacturing and construction. Further, there are few women in the science, technology, engineering and mathematics (STEM) job families and may therefore not be able to take advantage of the increased demand for workers with skills in these areas.[9]

7. Taken together, rapid technological change offers potentially transforming development opportunities for countries but also creates significant concerns that policymakers need to address to ensure technologies are leveraged for sustainable and inclusive development. Development gains offered by new and emerging technologies are not automatic. While new technologies create new jobs and development opportunities, they also increase the demand for digital skills and competencies.[10] This underlines the importance of addressing the gaps that exist in terms of capabilities across and between countries, sectors and segments of the society, so that societies can adapt and benefit from technological changes.

II. Digital skills and competencies

8. Estimates indicate that 85–90 per cent of future jobs will require ICT skills by 2020.[11] More than a third of the labour force in OECD countries, however, is reported to have an extremely low capacity to use digital technologies productively, while 56 per cent of the population has no ICT skills.[12] Also, women were more likely than men to lack digital skills. The widening gap between the knowledge, skills and abilities of young people entering the workforce and the knowledge, skills, and abilities that employers are seeking has been identified as an important deterrent to growth.[13] Moreover, developing countries are witnessing an increase of young people in the labour market. About half a billion young Chinese and Indian people will join the workforce in the coming decades. In Africa, it is expected that about 11 million young Africans will join the labour market every year for the next decade.[14] This stresses the need for policymakers and educators to adapt educational curricula to changing labour markets demands.

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[7] OECD, 2017, Going digital: The future of work for women, Policy Brief on The Future of Work.

[8] UNCTAD, 2017, *Information Economy Report 2017: Digitalization, Trade and Development* (United Nations publication, Sales No. E.17.II.D.8, New York and Geneva).

[9] E/CN.16/2016/3.

[10] Further, inequality in the skills that allow people to use technologies is one factor that could potentially exacerbate the digital divide. In addition to access to the Internet, ICT user sophistication and digital skills for Internet use have also been identified as determinants of the digital divide. See E Hargittai, 2003, How wide a Web? Inequalities in accessing information online; E Hargittai and A Hinnant, 2008, Digital inequality differences in young adults' use of the Internet, *Communication Research*, 35(5):602–621.

[11] https://ec.europa.eu/jrc/en/news/job-market-fails-unleash-ict-potential-9692 (accessed 27 February 2018).

[12] Broadband Commission for Sustainable Development, 2017, Working Group on Education: Digital Skills for Life and Work.

[13] The Economist Corporate Network, 2016, *Shaping the Future of Work: Technology's Role in Employment* (Dubai).

[14] https://openknowledge.worldbank.org/bitstream/handle/10986/25010/Will0the0digit00realizing0job0gains.pdf?sequence=1&isAllowed=y (accessed 28 February 2018).

9. At the same time, the effects of ICTs are not limited to jobs but also to social and civic participation in societies. Having the necessary digital competencies enhances people's quality of life and the effectiveness of their work. Therefore, digital competencies and skills are essential to ensure effective participation in the current and future world as well as to benefit from existing and emerging technologies.

A. Digital skills and competencies for the twenty-first century

10. In general, digital competence encompasses the knowledge and skills required for an individual to be able to use ICT to accomplish goals in his or her personal or professional life. Digital competencies should be perceived as not only concerned with technical skills, but more focused on cognitive and social and emotional aspects of working and living in a digital environment.[15] The notion is a complex one, and beyond digital literacy, implies the ability to understand media, to search for information and be critical about what is retrieved, and to be able to communicate with others using a variety of digital tools and applications. Digital competence is a multifaceted moving target, which is constantly evolving as new technologies appear.[16]

11. Different types of digital competencies are needed to adapt to the changing technological landscape. Six major drivers are among those relevant for the work skills and digital competences of the future: increasing globalization, extreme longevity, workplace automation, fast diffusion of sensors and data processing power, ICT-enabled communication tools and media, and the unprecedented reorganization of work driven by new technologies and social media, which are massively increasing collaboration opportunities.[17] Several organizations and initiatives have carried through efforts to identify and categorize the digital skills and competencies needed for the future. Table 1 presents examples of selected categorizations of such skills and competencies.

Table 1
Different categorizations of digital skills

Job-ready digital skills for decent jobs (International Labour Organization and International Telecommunication Union (ITU))	Advanced digital skills (coding and other algorithmic knowledge) Basic digital skills (related to the use of technologies) Soft skills (such as communication and leadership) Digital entrepreneurship (online market research and using financial platforms)
Work-related skills (World Economic Forum)	Abilities (cognitive and physical) Basic skills (content and processing skills) Cross-functional skills (social systems, complex problem solving, resource management and technical skills)
Future of work (OECD)	Technical and professional skills (specific and often industry-specific skills such as installation and operation of robots) Generic ICT skills (skills needed to understand, use and adopt technologies; life-learning ability to adapt to technology changes) Complementary ICT soft skills (creativity, communication skills, critical and logical thinking, teamwork, digital entrepreneurship)

Source: ITU, 2018, ILO-ITU Digital Skills for Decent Jobs for Youth Campaign to train 5 million youth with job-ready digital skills; OECD, 2016, Skills for a digital world. Policy Brief on the Future of Work. World Economic Forum, 2016, *The Future of Jobs: Employment, Skills and Workforce Strategy for the Fourth Industrial Revolution* (Geneva).

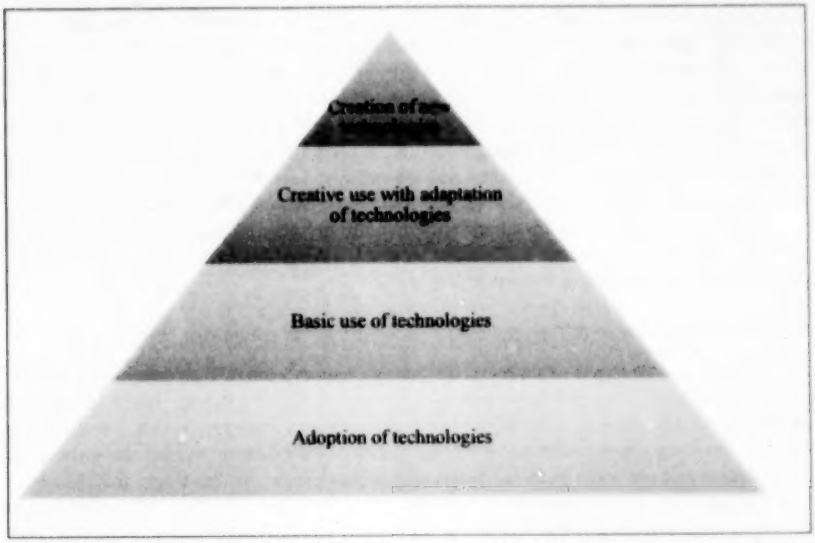
[15] Y Eshet-Alkai, 2004, Digital literacy: A conceptual framework for survival skills in the digital era. *Journal of Educational Multimedia and Hypermedia*, 13(1):93–106.

[16] A Ferrari, 2013, *DIGCOMP: a Framework for Developing and Understanding Digital Competence in Europe* (European Union, Luxembourg).

[17] Institute for the Future, 2011, Future Work Skills 2020.

12. Four different levels of digital skills are needed during the process of adoption, use and domestication of technologies: those required to adopt technologies, those needed in the basic use of technologies, those necessary for the creative use and adaptation of technologies, and those essential for the creation of new technologies. These categories can be further grouped into two categories: skill sets for all and skill sets for ICT professionals (see figure and table 2).

Pyramid of digital skills



Source: P DiMaggio, E Hargittai, C Celeste and S Shafer, 2004, Digital inequality: From unequal access to differentiated use, in *Social Inequality* (Russell Sage Foundation).

Table 2
Categories and levels of digital skills

Category	*Levels*	*Skills*
Digital skills for all	Adoption	Basic education and literacy Familiarity with technology devices and services
	Basic or generic use	Basic understanding of technologies, software and applications; Knowledge of digital rights, privacy, security and permanence of data[a] Ability to make use of information and data, ranging from basic issues of data storage, management, and organization to construct calculations and answer questions[a] Ability to using digital technologies to collaborate, communicate and create[a]
Digital skills for ICT professionals	Creative use and adaptations	Basic computing skills Familiarity with basic algorithms
	Creation of new technologies	Sophisticated programming skills; knowledge of complex algorithms

Source: Di Maggio et al., 2004.

[a] Broadband Commission for Sustainable Development, 2017.

Digital competencies for all: Adoption and basic use of technologies

13. The most fundamental skill sets for individuals and companies in the digital era are capabilities to adopt new technologies. In this context, "digital literacy for all" is a basic requirement to enable every citizen to participate fully in the digital society.[18] For individuals, this involves basic education and literacy, as well as familiarity with technology devices; for companies, this contains knowledge about ICT installations in the existing business system. After individuals and companies have basic access to technologies, the next levels of digital skills are those that facilitate the direct use of technologies, which include a basic understanding of emerging technologies and technology applications, and knowledge about digital privacy and security. This type of knowledge enables users to actively extract the information they need from the Internet, instead of passively being receivers and targets of online advertisements.[19] Knowing how technology works can help users improve the efficiency of usage and optimize the outcome of technology usage. With increasing numbers of software and applications being used to accomplish everyday communicational and informational tasks, basic knowledge of ICTs is now essential for citizens to solve everyday problems, as well as to engage in community activities. Some non-ICT professionals may increasingly need to develop stronger skills to perform their duties. Some of these skills include proficiency in programming languages, data analysis and processing and modelling skills.[20]

Digital competencies for ICT professionals: Adaptation and creation of technologies

14. There are two types of digital skills that are required for ICT professionals: skills to adapt and creatively use available technologies, and skills to innovate based on adapted technologies. The former is required for individuals or companies that have already acquired basic computing skills or have hired technical staff that can modify the software or technologies to meet individualized needs and requirements. At this stage, individuals or ICT departments within companies understand basic algorithms, and can use online resources to create new functions or develop more suitable applications when needed. Although a degree in ICT-related subjects such as computer science is not required at this level, training in statistics, programming languages and big data analytics are necessary. The ability to redesign or modify technologies for creative use is also the key for localizing emerging technologies in developing countries. Skills to innovate based on adapted technologies include sophisticated programming skills and knowledge of complex algorithms.

15. Many of the advanced technologies are designed to be used in contexts where infrastructure, and natural and social resources differ from those in developing economies. To maximize the benefits of new technology, countries and companies in developing countries need to have the digital skills to introduce modifications to new technologies.[21] The creation of new technology is the final and the most advanced level of digital skills. Individuals who have sophisticated programming skills or companies that have a good knowledge of complex algorithms such as machine learning, will have the capabilities to contribute to the creation of more advanced technologies or the development of technology innovations.

16. While education and training programmes that focus on digital skills for all – including training in the adoption and use of technology – should be inclusive and accessible to everyone, needs for other types of digital competencies vary across sectors, countries and levels of industrial development. In countries where technology development remains in its early stages, basic technical skills and generic skills are the most required. Countries where the manufacturing sector dominates economic growth will require talents, experts and a workforce with specialized skills in industrial robotics, automation and the

[18] Broadband Commission for Sustainable Development, 2017.

[19] WR Neuman, 2016, *The Digital Difference: Media Technology and the Theory of Communication Effects* (Harvard University Press, London).

[20] Broadband Commission for Sustainable Development, 2017.

[21] Z Huang and P Palvia, 2001, ERP implementation issues in advanced and developing countries, *Business Process Management Journal*, 7(3):276-284.

Internet of Things. Skills that enable workers to work with new technologies are increasing; as a result, certain complementary soft skills are also needed in digitally transformed manufacturing environments.[22] In countries where the services industries, such as tourism, and financial and health-care services, are prosperous and growing, there is a higher demand for sophisticated and specialized digital competencies.

B. Complementary skills

17. Digital skills are not enough to adapt to the changing labour markets demands. There is an increasing demand to strengthen those unique human skills that cannot be easily replaced by machines, computers and robots. In addition to digital competencies, building and strengthening complementary skills such as complex problem solving, critical thinking, and creativity, are essential to create the flexibility required for the current and future demands for the workforce.

18. Research shows that occupations such as engineering and science are less susceptible to digitalization and computerization because these professions involve a higher degree of creativity and innovation compared with other jobs.[23] Occupations that involve sophisticated communication skills are also in a more secure position in the digital era. For example, natural language processing algorithms can detect emotions underlying text, but are often inaccurate in comprehending sarcasm, humour or irony. When equipping a future workforce with complementary soft skills, it is also important to develop critical and logical thinking abilities, which are vital when preparing young people with abilities in problem solving and decision-making. With the increase of the platform economy, soft skills for digital entrepreneurship are important for individuals to benefit from the digital economy.[24] Many countries have highlighted the importance of providing related training on e-business. For instance, Turkey aims to increase the percentage of individuals with entrepreneurship training from 6.3 per cent in 2012 to 15 per cent in 2018.[25] A non-exhaustive list of complementary skills is presented in table 3.

[22] National Academies of Science, Engineering, and Medicine, 2017, *Information Technology and the United States [of America] Workforce: Where Are We and Where Do We Go from Here?* (National Academies Press, Washington, D.C.).

[23] CB Frey and MA Osborne, 2017, The future of employment: How susceptible are jobs to computerization? *Technological Forecasting and Social Change*, 114(C):254-280.

[24] Contribution from United Nations Major Group for Children and Youth. In addition to training, other factors also influence entrepreneurship initiatives, particularly of youth. These include risk management, high overhead costs and difficulty in gaining financial and legal legitimacy.

[25] Contribution from the Government of Turkey, available at http://unctad.org/meetings/en/Contribution/CSTD_2018_IPanel_T2_DigitalComp_con23_Turkey_en.pdf (accessed 27 February 2018).

Table 3
Complementary soft skills for the future workforce

Type of soft skills	*Description*
Sense making	Ability to determine the deeper meaning or significance of what is being expressed
Social intelligence	Ability to connect with others in a deep and direct way, to sense and stimulate reactions and desired interactions
Computational thinking	Ability to translate vast amounts of data into abstract concepts and to understand data-based reasoning
Novel and adaptive thinking	Proficiency at thinking and coming up with solutions and responses beyond that which is rote or rule based
Cross-cultural competency	Ability to operate in different cultural settings
New media literacy	Ability to critically assess and develop content that uses new media forms, and to leverage these media for persuasive communication
Transdisciplinarity	Literacy in the ability to understand concepts across multiple disciplines
Design mindset	Ability to represent and develop tasks and work processes for desired outcomes
Cognitive load management	Ability to discriminate and filter information for importance, and to understand how to maximize cognitive functioning using a variety of tools and techniques
Virtual collaboration	Ability to work productively, drive engagement, and demonstrate presence as a member of a virtual team

Source: Institute for the Future, 2011.

III. Emerging and existing technologies for education

19. Traditional teaching curricula and training programmes can contribute to the enhancement of digital skills; in addition, new and emerging technologies can also help build digital competencies. In particular, digital technologies enable interactions between educators and students, provide multimedia interfaces that facilitate learning and increase flexibility in the delivery of training. Recent literature has identified massive open online courses, open access to scientific literature and educational resources, and technology-mediated teaching and learning as some of the existing and emerging technologies that can potentially contribute to building digital skills and competencies.[26]

A. Massive open online courses

20. Massive open online courses are online courses that allow for open access and participation through the World Wide Web and that could contribute to e-learning. They offer various features in addition to online video lectures, including online social sharing and interactive learning methods, community teaching assistants that moderate discussion forums and tracking of the activities and performance of students. Potentially, these courses could deliver mass education at a low cost and help achieve Sustainable Development Goal 4 ("ensure inclusive and equitable quality education and promote lifelong learning opportunities for all"). There are a variety of factors, however, that may

[26] For instance, the Commission on Science and Technology for Development examined open access, virtual libraries and the potential of massive open online courses in education delivery during its fifteenth and nineteenth annual sessions. See www.unctad.org/cstd (accessed 27 February 2018).

reduce the potential access and use of these courses, including issues related to infrastructure access (since these courses require users to have access to a reliable Internet connection, including upgraded software and hardware) and to the content of the educational material (courses are generally available in English and may not consider relevant local content).[27] These issues underscore the importance of reducing the digital divide and considering local needs in the developing the courses.

B. Open access to scientific literature and educational resources

21. The creation of new technologies requires the exchange of information and knowledge worldwide. Open access databases and journals of scientific literature allow scientific knowledge to be accessed without cost. Open access publishers, such as the Public Library of Science, distribute digital copies of research articles online and provide open access for users.[28] Traditional scientific publishers are also helping make science accessible in developing countries.[29]

22. Scientists are increasingly using archiving websites to share their research with a much wider audience. For instance, the Bexar County Digital Library in San Antonio, Texas, United States, offers digital content, access to online databases and educational resources to increase literacy and digital literacy among lower socioeconomic communities.[30] Other related efforts include the development of educational resources openly available for use by educators and students, without an accompanying need to pay royalties or licence fees.[31] For instance, Latvia has a natural sciences and mathematics project that has allowed the production of supporting materials for teachers in biology, physics, mathematics and chemistry (International Standard Classification of Education level 2), which are available on the Internet.

C. Technology-mediated teaching and learning

23. Existing and emerging technologies such as the Internet can help build digital competencies by making learning materials accessible to teachers and students. For instance, in Bulgaria the Daskal.eu initiative uses an online platform to connect students and teachers by providing technological tools for setting up virtual classrooms and real-time video streams. Among the users of this type of platform are freelance teachers, students in need of extracurricular classes and, in some cases, whole schools conducting some of their classes from a distance.[32] In South Africa, the Digital Doorway programme provides women in remote rural areas with ICT access to obtain agricultural information.[33]

24. In remote areas, media centres could serve as educational institutes that, in addition to providing education, can also track and assess the performance of students. For example, a media centre in Brazil helps children in remote communities to continue schooling. The centre provides technologies and complementary human interaction. While a bidirectional camera enables teachers to interact with students remotely, a tutoring teacher supports the students' learning by helping manage classes and administrative

[27] B Moser-Mercer, 2014, Massive open online courses in fragile contexts, Proceedings of the European Massive Open Online Courses Stakeholders Summit 2014, Lausanne, Switzerland, 10–12 February.

[28] https://www.plos.org/open-access/ (accessed 27 February 2018).

[29] http://www.pnas.org/site/aboutpnas/developingcountries.xhtml (accessed 27 February 2018).

[30] Contribution from the Government of the United States, available at http://unctad.org/meetings/en/Contribution/CSTD_2018_IPanel_T2_DigitalComp_con26_US_en.pdf (accessed 27 February 2018).

[31] For more information on open educational resources, see http://unesdoc.unesco.org/images/0021/002158/215804e.pdf (accessed 27 February 2018).

[32] Contribution from the Government of Bulgaria, available at http://unctad.org/meetings/en/Contribution/CSTD_2018_IPanel_T2_DigitalComp_con15_Bulgaria_en.pdf (accessed 27 February 2018).

[33] Contribution from the Government of South Africa, available at http://unctad.org/meetings/en/Contribution/CSTD_2018_IPanel_T2_DigitalComp_con22_SouthAfrica_en.pdf (accessed 27 February 2018).

issues.[34] Therefore, students benefit from technological advances because remote learning becomes a more interactive and engaging experience.

25. New technologies, such as artificial intelligence and big data analytics, can also help teachers make assessments or provide feedback by, among others, producing intelligent scoring, interpreting of individual profiles and providing advice to learners and teachers by inference procedures.[35] Assessment of performance is therefore done in real time; in addition, it is flexible and embedded in the teaching process.

26. Table 4 describes some examples of potential uses of big data for education. General Assembly and Singularity University, both located in the United States, are two examples of educational organizations created to cater for the growing demand for digital skills and lifelong learning, and to interact with and develop technologies developing at exponential rates.[36]

Table 4
Potential uses of big data for education

Beneficiaries	*Potential contribution of big data*
Students in schools, colleges and university	Provide feedback on their measured progress and recommendations on what to do to improve
Teachers	Review and evaluate courses and track student's engagement and achievement
School and university leaders	Review and evaluate intuitional and staff performance at the same time
Policymakers	Help learn about institutional and system performance and generate insights for future policy intervention

Source: B Williamson, 2017, *Big Data in Education: The Digital Future of Learning, Policy and Practice* (Sage, London).

27. To benefit from technologies in education, it is necessary to have access to reliable and updated ICT infrastructure, ensure the continuous training of teachers and consider the long-term sustainability of the programmes. Also, resources should be adapted and restructured to fit local contexts for youth in low-and-middle-income countries, especially in rural regions.[37]

28. Further, digital learning technologies such as massive open online course do not guarantee improved educational outcomes, and only through experimentation, monitoring and evaluation can its impact be assessed. Also, when analysing the sustainability and scaling up of e-learning projects, the educational goals and pedagogical approaches appropriate for a specific country or region should be considered.

IV. Initiatives to help build competencies

29. Building the competencies and skills required to understand, adopt, use and create new technologies, particularly ICTs, is central for individuals to participate effectively in and benefit from technologies. Digital competencies, soft skills and access to new technologies, however, are not equally distributed among regions and groups. Therefore, some countries do not have the capacities to leverage technology for development.

[34] https://www.brookings.edu/research/millions-learning-scaling-up-quality-education-in-developing-countries/ (accessed 27 February 2018).

[35] C Redecker and O Johannessen, 2013, Changing assessment: Towards a new assessment paradigm using ICT, *European Journal of Education*, 48(1):79–96.

[36] https://www.economist.com/news/special-report/21714169-technological-change-demands-stronger-and-more-continuous-connections-between-education (accessed 27 February 2018).

[37] Contribution from United Nations Major Group for Children and Youth.

The rapid pace of technological development requires constant adaptation and flexibility in the types of competencies required. This stresses the need for developing and developed countries alike to put competence building at the forefront of their development strategies. This section describes three areas in which concerted efforts are required to enable and promote the creation and strengthening of digital competencies and soft skills.

A. Incorporating digital competencies in the education system

30. Education is central to preparing the workforce and society to benefit from exponential technologies. Also, training is central to people's ability to leverage technologies for innovation and sustainable development. Education policy needs to accommodate new requirements for digital skills training schemes, making acquisition of digital competencies part of the education goals. Furthermore, the changes in the types of skills and competencies needed to take advantage of current and emerging technologies have implications for formal education systems, as well as for private and public skills development strategies. This will require changes to education and training systems, as well as individual attitudes, and it may involve crafting appropriate curricula now for skills and jobs that will be required in the future.[38] Training in digital competencies, including soft skills, should be incorporated at all levels in the education system (primary, secondary, tertiary) and as part of vocational training and lifelong updating and upscaling of skills for the workforce. The programmes should allow for flexibility so they can be adapted according to technological changes.[39]

Building digital competencies at schools

31. Education policies should emphasize the importance of providing digital training to primary and secondary school students, and programmes and curricula should adjust and allow for flexibility so they can continously adapt to the changing technological landscape. It is important to consider teaching a broad range of skills, from simple operations of desktop computers and text processing tools, to more rigorous courses that teach students to understand fundamental computing languages, and establish their algorithmic thinking skills. Education programmes should consider mobile devices not only as information seeking tools but also as tools for productivity scenarios, since users seldom use mobile phones in activities such as job seeking or online learning.[40] Furthermore, education policies should also consider the continuous training of teachers. For instance, the teacher-training strategy of the Plurinational State of Bolivia provided ICT training to more than 200,000 teachers between 2010 and 2015.[41]

32. Encouraging the participation of girls in the study and professions of science, technology, engineering and mathematics in both developed and developing countries can help build intermediate- and advanced-level digital skills.[42] In higher education, girls represent 35 per cent of all students enrolled in such areas. Many reasons explain this bias, including societal and parental attitudes towards the abilities of boys and girls, access to education and bias in teaching material and curricula, as well as perceptions that girls are less able to "do" science.[43] Moreover, women who enter such professions leave in disproportionate numbers compared with men.[44] The integration of the broad field of the arts into science, technology, engineering and mathematics could potentially help increase women's engagement in these areas.[45]

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[38] UNCTAD, 2017.

[39] The Economist Corporate Network, 2016.

[40] J Donner, 2015, *After Access* (MIT Press, Cambridge, Massachusetts, United States).

[41] Contribution from the Government of the Plurinational State of Bolivia, available at http://unctad.org/meetings/en/Contribution/CSTD_2018_IPanel_T2_DigitalComp_con14_Bolivia_es.pdf (accessed 27 February 2018).

[42] Broadband Commission for Sustainable Development, 2017.

[43] UNCTAD, 2011, *Applying a Gender Lens to Science, Technology and Innovation*, UNCTAD Current Studies on Science, Technology and Innovation, No. 5 (United Nations publication, Geneva).

[44] Broadband Commission for Sustainable Development, 2017.

[45] https://stemdiversity.wisc.edu/featured/why-art-is-the-key-to-closing-the-stem-gender-gap/ (accessed 27 February 2018).

Digital competencies as part of vocational training

33. Introducing professional digital skills training, such as coding, data analysis and e-business skills, can help young people seize new opportunities offered in the future job market. For example, in the United Kingdom of Great Britain and Northern Ireland, the Ada National College for Digital Skills provides digital skills training to students, with a special focus on female students and those from lower-income backgrounds.[46] Another example is the Industry 4.0 project in Turkey, which aims to provide young students in vocational schools with skills training and knowledge in emerging technologies, such as the Internet of Things.[47] To provide digital skills in vocational education, schools should work closely with industry to update the content of curricula and courses, since technologies advance at a rapid pace, and workers need to upskill constantly. Creating interfaces between schools and industries can help facilitate this type of collaboration.

34. In addition, it is important to support firms, community school and civil society organizations working on the provision of training of broad skills to the existing workforce and the population. This should include broad skills in digital competencies such as basic ICT skills for work and for wide social life, lifelong learning capabilities and entrepreneurship skills.

Digital competencies and lifelong learning

35. Estimations suggest that by 2030, 75 million to 375 million workers, representing 3 to 14 per cent of the global workforce, will need to switch occupational categories.[48] What becomes relevant is to think in terms of skills – and not so much in terms of jobs – and match those skills with labour market needs. Furthermore, since technologies advance at an unprecedented speed, digital skills training programmes need to constantly update to provide the most important professional skills for adult students. The term "learnability" – the desire and capability to develop in-demand skills to be employable for the long term – has recently emerged to describe the key attribute that employers demand in an environment of rapid technological change.[49]

36. Traditional community centres such as libraries could provide new training programmes for members of the community. For example, as part of the National Strategy for Lifelong Learning (2014–2020) of Bulgaria, public libraries in this country provide digital skills training for various social groups.[50] In Poland, the Office of Electronic Communications organizes coding courses to strengthen the development of creative and analytical thinking.[51] It is also necessary to fully exploit the potential of digital technologies such as social media and online training in lifelong learning and on-the-job training.

37. As digital technologies become increasingly important for both employment and everyday life, women in developing countries require basic digital literacy to either compete with male workers in the job market or manage everyday household tasks. A project called the Citizens Foundation has conducted an assessment of women's digital

[46] Contribution from the Government of the United Kingdom, available at http://unctad.org/meetings/en/Contribution/CSTD_2018_IPanel_T2_DigitalComp_con25_UK_en.pdf (accessed 27 February 2018).

[47] Contribution from the Government of Turkey, available at http://unctad.org/meetings/en/Contribution/CSTD_2018_IPanel_T2_DigitalComp_con23_Turkey_en.pdf (accessed 27 February 2018).

[48] https://www.mckinsey.com/global-themes/future-of-organizations-and-work/what-the-future-of-work-will-mean-for-jobs-skills-and-wages (accessed 27 February 2018).

[49] https://www.weforum.org/agenda/2016/08/this-little-known-skill-will-save-your-job-and-your-company/ (accessed 27 February 2018).

[50] Contribution from the Government of Bulgaria, available at http://unctad.org/meetings/en/Contribution/CSTD_2018_IPanel_T2_DigitalComp_con15_Bulgaria_en.pdf (accessed 27 February 2018).

[51] Contribution from the Government of Poland, available at http://unctad.org/meetings/en/Contribution/CSTD_2018_IPanel_T2_DigitalComp_con20_Poland_en.pdf (accessed 27 February 2018).

educational needs and developed an online platform to facilitate literacy education for women living in rural Pakistan.[52] For women in developing countries, basic Internet connectivity should be provided by the Government to meet their ICT needs. The Government of Kenya aims to provide Internet access to local communities, which will include women and persons with disabilities.[53]

38. There is no one-size-fits-all or single recipe for education and lifelong learning policy, as it is important to consider the different circumstances of the countries in terms of the level of development and industrialization, skills needs and levels of education and training capabilities.

B. Importance of an enabling environment to support skills development

39. The creation of an environment facilitates building digital competencies and contributes to leverage their potential. An enabling environment is promoted through investment in infrastructure, institution development and entrepreneurship, among others.

Investment in digital infrastructure

40. A fundamental element of the digital capacity of countries is their digital infrastructure. Only those that are connected and that have the required capabilities will be able to take advantage of the development opportunities offered by current changes in technology. Therefore, in addition to investing in capacity-building, it is essential to reduce the digital divide. This can be achieved, for example, by investing in infrastructure.

41. Estimates show that almost 4 billion people – more than half the world's population – do not have Internet access.[54] Particularly noteworthy is the gender dimension of the digital divide. Although the gap has narrowed in terms of using the Internet (currently 12 per cent), it has widened in Africa (25 per cent) and in the least developed countries, where only one out of seven women use the Internet, compared with one out of five men. Broadband connectivity in developing countries, when available, tends to be relatively slow and expensive, limiting the ability of businesses and people to use it productively. Infrastructure investment is critical to tackling the inequalities in access and leveraging benefits from existing and emerging technologies, particularly in the least developed countries, landlocked countries and small island developing States where geographical constraints, low population densities and limited resources make it more difficult for private investors to secure rapid returns on capital. In this regard, international financial institutions and development partners have an important role to play, alongside private sector businesses and Governments.

42. Moreover, there is an infrastructure gap between technology adoption at home and in the classroom. While families and individuals widely adopt ICTs, recent research suggests that schools lag behind in the adoption of new technologies: 96 per cent of students in OECD countries have computers at home, but only 72 per cent reported using ICTs at school.[55] This gap between school and home use of ICTs is wider in developing countries, where villages and local communities have shortages of public ICT facilities. To narrow the technology gap at home, it would be advisable to build information centres equipped with ICT facilities in local communities or to provide affordable mobile technologies such as tablets to low-income families. For example, a public-private partnership in the United States, ConnectHome, provides free or low-cost broadband

[52] https://en.unesco.org/news/community-engagement-and-online-literacy-empower-girls-and-women-pakistan (accessed 28 February 2018).

[53] Contribution from the Government of Kenya, available at http://unctad.org/meetings/en/Contribution/CSTD_2018_IPanel_T2_DigitalComp_con18_Kenya_en.pdf (accessed 27 February 2018).

[54] ITU, 2017, *ICT Facts and Figures 2017* (Geneva).

[55] OECD, 2015, *Students, Computers and Learning: Making the Connection* (OECD Publishing).

access, and device and digital literacy training to low-income families, aiming to narrow the digital divide at home.[56]

43. Investment in digital infrastructure includes investing in data resources and the facilities and capabilities for collecting, analysing and using big data. Efforts in this area include building national big data centres, achieving full broadband coverage in developing countries and investing in regional high-speed computing and processing facilities for big data analysis. Investment in infrastructure can also help build digital competencies. For instance, online platforms and education applications can help countries educate and train the workforce and citizens. However, to make data to work for societies, it is also necessary to build analytical capabilities in policy- and decision-making processes.

Policy and institutional development

44. To build digital competencies, it is essential to have appropriate institutions that set rules creating incentives that motivate workers, management, firms, universities and other entities to adopt and develop the necessary skills. These institutions include laws and regulations, organizations such as vocational schools and community schools that support professional training and lifelong learning, university departments and centres that conduct research and develop digital technologies and their applications, non-governmental organizations and social organizations that provide support to the wider society for digitalization, adoption and use.

45. Other efforts in areas such as taxation, financing, industry and labour market policies can also help develop an incentive structure that encourages and facilitates investment and labour participation in the digital economy. A descripiton of selected national strategies aimed at equipping countries with the resources needed to benefit from technogical advances is provided in the following box.

[56] Contribution from the Government of the United States, available at http://unctad.org/meetings/en/Contribution/CSTD_2018_IPanel_T2_DigitalComp_con26_US_en.pdf (accessed 27 February 2018).

Selected national strategies aimed at increasing digital competencies of countries

- Bulgaria. Digital Bulgaria 2020 programme: Sets forth the country's current priorities in the global process of digitalization, including bridging the digital divide, increasing digital literacy and competencies of individuals, and reducing the shortage of highly qualified workers in the high-technology sector.

- Canada. Innovation and Skills Plan: Aims to make Canada a world-leading centre for innovation, help create more well-paying jobs, and strengthen and expand the middle class. It includes equipping citizens with the tools, skills and experience they need to succeed in the workforce, now and in the future.

- Kenya. National ICT Master Plan: Road map based on the ICT theme "Strengthening the foundation for a knowledge-based economy". Considers strategies to enhanced public value, development of ICT businesses and strengthening of ICT as a driver of industry.

- Portugal. National Digital Competences Initiative e.2030 (INCoDE.2030): Brings together public and private organizations to generalize digital literacy, stimulate employability, professional training and specialization in digital technologies and applications, and ensure strong participation in international research and development networks and the production of new knowledge in digital areas.

- South Africa. Revised National Broadband Policy and Broadband Strategy: Aimed at ensuring universal access to reliable, affordable and secure broadband infrastructure and services by 2020 and stimulating sustainable uptake and usage of ICTs.

- Uganda. Digital Uganda Vision: Addresses issues related to infrastructure support, policy framework, access to ICTs, capacity development, collaboration among various agencies, common access of government services by citizens, delivery of services and participative access.

- United Kingdom. Digital Skills and Inclusion Policy: Aims to ensure that everyone who is capable of participating in the digital economy does so.

- United States. Federal Open Data: An open government data initiative that contributes to modernizing government and improving the delivery of services provided by government, industry and non-governmental organizations.

Source: Contributions from Member States of the Commission on Science and Technology for Development, available at http://unctad.org/en/pages/MeetingDetails.aspx?meetingid=1562 (accessed 27 February 2018).

C. Collaboration among stakeholders

46. The improvement of digital competencies requires extensive investment in training staff, designing curricula and providing information centres, all of which call for more in-depth international collaboration. There are several areas in which collaboration among stakeholders can contribute to the strengthening of digital competencies in countries, for instance, through public–private partnerships in delivering digital skills and building digital infrastructure, and through international collaboration among stakeholders for capacity-building and research.

Public–private partnerships

47. Public–private partnerships can support training provision, infrastructure development and building of data facilities. Technology companies are already playing important roles in some developed countries to support the training and teaching of digital skills. For example, Microsoft works with the British Government to train civil servants how to use new technologies such as cloud services.[57] Furthermore, since technology companies have advantages in software engineering and interface designing, there is also potential for collaboration that considers the provisions of equipment and software specifically designed for educational purposes. Developers of Swift, an educational application on electronic devices, design an interactive and playful interface for children to learn to code.[58] Also, collaboration among stakeholders can also contribute to sharing information on demand and supply of skills digital competencies, provide on-the-job training and internships; and introduce cutting-edge technological skills to learners. For example, Portugal established a partnership with several universities, including the Massachusetts Institute of Technology, Carnegie Mellon University and Indian Institutes of Technology, to establish networks that support the enhancement of digital competencies.[59]

International collaboration

48. International collaboration can contribute to the strengthening of digital competencies in countries. Examples thereof include coding courses for teachers and students implemented in Rwanda by Germany and other stakeholders in 2016[60] and the international online forum Code Club, supported by the Raspberry Pi Foundation, a charity based in the United Kingdom. This organization works with institutions in over 100 countries to provide training materials for educators and volunteers around the world to teach children how to code.[61]

49. Collaboration among Governments, businesses and other stakeholders can also help build ICT infrastructure; accelerate the development of digital skills; build storage and analysis capabilities; and develop regulations and ethics in data collection, usage and open access. For instance, Uganda built an information access centre with the assistance of the Government of Korea to facilitate e-government initiatives.[62] Partnerships such as "EQUALS" – a global partnership for gender equality, led by ITU and the United Nations Entity for Gender Equality and the Empowerment of Women, can also play a useful role in this regard.[63]

50. Also, multi-stakeholder forums such as the Commission on Science and Technology for Development, can contribute to exploring technological advances and their policy implications for countries in terms of capacity-building. In addition, they can facilitate and promote formal collaboration between countries and stakeholders' groups, as well as facilitate the exchange of good practices and lessons learned in promoting digital competencies.

[57] https://news.microsoft.com/en-gb/2017/01/26/microsoft-launches-digital-skills-programme-for-the-uk/ (accessed 27 February 2018).

[58] https://www.apple.com/uk/swift/playgrounds/ (accessed 27 February 2018).

[59] Contribution from the Government of Portugal, available at http://unctad.org/meetings/en/Contribution/CSTD_2018_IPanel_T2_DigitalComp_con21_Portugal_en.pdf (accessed 27 February 2018).

[60] Contribution from the Government of Germany, available at http://unctad.org/meetings/en/Contribution/CSTD_2018_IPanel_T2_DigitalComp_con17_Germany_en.pdf (accessed 27 February 2018).

[61] https://www.codeclubworld.org/about/countries/ (accessed 27 February 2018).

[62] Contribution from the Government of Uganda, available at http://unctad.org/meetings/en/Contribution/CSTD_2018_IPanel_T2_DigitalComp_con24_Uganda_en.pdf (accessed 27 February 2018).

[63] https://www.equals.org/(accessed 27 February 2018).

V. Suggestions for consideration by Member States, the international community and the Commission on Science and Technology for Development at its twenty-first session

51. Digital technologies are already producing an impact on many areas of social and economic life, including employment opportunities. The deployment of existing and emerging technologies offers potential to support the achievement of the 2030 Agenda for Sustainable Development, particularly in areas such as health, education, agriculture, new enterprise development, gender equality and environmental sustainability. However, rapid technological change also creates concerns and challenges, since new technologies can also increase inequalities. Building digital competencies can help countries maximize the benefits and reduce the negative effects of new technologies in societies.

52. Member States are encouraged to take the following steps:

(a) Implement initiatives and programmes that encourage and facilitate investment and labour participation in the digital economy. These include training (for example, digital entrepreneurship), online platforms, community activities, financial incentives (for example, tax breaks and low-interest bank loans), funding for small and medium-sized enterprises engaged in digital technology, promotion of e-business and entrepreneurship, and automation or digitalization of existing businesses;

(b) Implement policies aimed at establishing adequate ICT infrastructure. These include promoting investment in infrastructure and data resource capabilities, including facilities for data collection, storage, and transmission; capabilities for big data analysis and decision-making; and appropriate tools to provide and benefit from open government data;

(c) Incorporate the provision of digital competencies and complementary soft skills, including entrepreneurship, in formal education curricula and lifelong learning initiatives. This should take into consideration best practices, local contexts and needs, and ensure that education is technology neutral;[64]

(d) Promote the study of science, technology, engineering and mathematics, particularly among female students, while also recognizing the importance of studies that incorporate the arts within traditional technical subjects. Training also should be provided to teachers, particularly in areas such as digital skills and computational thinking. Capacity-building in these areas can be provided in combination with training in other general skills, such as entrepreneurship and soft skills, and should consider mandatory training in gender bias awareness;

(e) Support firms and other stakeholders in the provision of training of broad digital competencies for the workplace and in wider social life, lifelong learning capabilities and entrepreneurship skills. Collaboration among stakeholders, including public–private partnerships, should be promoted to support infrastructure development, and the building of data facilities. Special attention should be devoted to policies and partnerships that target the creation and strengthening of digital competencies and skills in youth and women;

(f) Implement support mechanisms to identify trends in ICT development and skills needs, such as foresight, that help workers meet current and emerging demands for competence, and help workers and enterprises adapt to change;

53. The international community may wish to consider the following suggestions:

(a) Foster closer collaboration among different international organizations and with civil society organizations to create initiatives that aim to build digital skills, including hackathons, workshops and other interactive forums;

(b) Identify ICT infrastructure requirements that enable meaningful training in digital skills and competencies;

[64] In other words, education that does not promote specific technologies.

(c) Promote the use of digital methods, such as online platforms for international knowledge sharing and capacity-building.

54. The Commission may wish to consider the following suggestions:

(a) Strengthen the Gender Advisory Board, particularly with respect to building digital competencies, in collaboration with relevant United Nations entities focusing on digital technologies and gender;

(b) Foster closer international cooperation to build linkages in academia across different countries, particularly to create opportunities for students in developing countries to go on exchange programmes in other countries with sophisticated education systems, as well as for commercialization innovations from research institutions in developing countries;

(c) Support the provision of training programmes for policymakers in interdisciplinary topics related to technological change and its development implications and facilitate dialogue between policymakers and science counterparts to keep them abreast of technological developments and their impacts;

(d) Support efforts to build capacity to develop, use and deploy new and existing technologies in developing countries, particularly in the least developed countries;

(e) Support countries in their efforts to identify future trends in terms of capacity-building needs, including through foresight exercises;

(f) Encourage knowledge sharing between Member States and other stakeholders, not only about best practices and success stories, but also about failures and challenges associated with building digital competencies.